SYNCHRONIZATION METHOD AND APPARATUS IN A VALUE METERING SYSTEM HAVING A DIGITAL PRINT HEAD

Field of the Invention

The present invention relates generally to a value metering system and, more particularly, to a postage meter having a digital print head to print a pattern of substrates one line at a time.

Background of the Invention

Manually-activated postage meters are well-known in the art. Typically, an envelope or a tape is manually fed under a print head for printing an indicium thereon. The print head is fixedly mounted in the postage meter, and a sensing device is used to sense the presence of the envelope under the print head. In order to print the indicium with minimum distortion, the speed of the envelope must be controlled to match the print speed of the print head. Thus, some mechanism must be used to synchronize the movement of the envelope to the print head. U.S. Patent No. 4,168,533 (Schwartz) discloses a micro-computerized miniature postage meter, wherein a microcomputer is used to actuate an inkjet printing device to project ink droplets onto a substrate moving relative to the printing device. In particular, the movement of the printing device relative to the substrate is detected by an encoded rotating wheel mounted on the lower contact surface of the printing device. The rotating wheel is coupled to an interrupter disc, which is adapted to provide signal pulses for coordinating the proper time for actuating of the printing device. With such a design, the postage meter becomes costly to produce and to sell.

Thus, it is advantageous and desirable to provide a simple synchronization method and apparatus for use in a value metering system, such as a postage meter.

Summary of the Invention

The first aspect of the present invention is an apparatus for achieving synchronization in a value metering system. In particular, the value metering system uses a digital print head capable of printing a plurality of printed lines on a substrate, which is displaced relative to the print head in a moving direction, wherein the lines are substantially perpendicular to the moving direction, and a first signal is provided after a line is printed. The apparatus comprises:

a first mechanism operable at a first position to restrict the displacement of the substrate and a second position to effectively disengage from the substrate, wherein the first mechanism is operated at the first position while the print head is printing a line; and

a second mechanism, responsive to the first signal, for causing the first mechanism to operate at the second position, thereby allowing the displacement of the substrate by a predetermined distance relative to the print head for printing a next line.

Preferably, the apparatus further comprises a third mechanism, responsive to the displacement of the substrate, for providing a second signal, indicative of the displacement of the substrate by the predetermined distance for causing the print head to print the next line. The third mechanism can be an optical sensor, a mechanical sensor, or the like.

Preferably, a third signal, indicative of a last printed line, is provided for preventing the first mechanism from further operating at the first position after the last line is printed.

Preferably, the substrate is manually displaced, but it is possible that the substrate is displaced by a movement device.

The second aspect of the present invention is a method of achieving synchronization in a value metering system using a digital print head capable of

printing a plurality of lines, one line at a time, on a substrate which is displaced in a moving direction relative to the print head, wherein the lines are substantially perpendicular to the moving direction. The method comprises the steps of:

engaging the substrate with a first mechanism capable of restricting the displacement of the substrate while the print head is printing a line;

providing a first signal indicating said line is printed;

disengaging the first mechanism from the substrate in response to the first signal; and

displacing the substrate by a predetermined distance for printing a next line.

Preferably, the method further comprises the step of providing a second signal indicative of the displacement of the substrate by the predetermined distance for causing the print head to print the next line, wherein the predetermined distance is substantially equal to the width of the lines or proportional to the width of the lines.

Preferably, the method further comprises the step of preventing the first mechanism from further restricting the displacement of the substrate after a last line is printed.

The third aspect of the present invention is a value metering system for printing a substrate. The value metering system comprises:

a digital print head capable of printing a plurality of lines, one line at a time, on the substrate, wherein the substrate is displaced relative to the print head in a moving direction;

a first mechanism capable of operating at a first position to restrict the displacement of the substrate and a second position to disengage from the substrate, wherein the first mechanism is operating at the first position when the print head prints a line;

a second mechanism, responsive to said printing, for providing a first

signal indicating said line is printed; and

a third mechanism, responsive to the first signal, for causing the first mechanism to operate at a second position, thereby allowing the displacement of the substrate by a predetermined distance for printing a next line.

Preferably, the value metering system also includes a fourth mechanism, responsive to the displacement of the substrate by the predetermined distance, for causing the print head to print the next line.

Preferably, the value metering system also includes a fifth mechanism, operatively connected to the print head for preventing the first mechanism from further operating at the first position after a last line is printed.

The value metering system can be a countertop system or a hand-held system.

It is possible that the substrate is manually displaced, but it is also possible that the substrate is displaced by a movement device.

The present invention will become apparent upon reading the description taken in conjunction with Figures 1 to 7.

Brief Description of the Drawings

Figure 1 is a diagrammatic representation illustrating the principle of synchronizing the printing speed of a print head and the displacement of a substrate to be printed, according to the present invention.

Figure 2 is a diagrammatic representation illustrating a postage indicium and a print line on a substrate.

Figure 3 is a diagrammatic representation illustrating a hand-held postage meter.

Figure 4 is a diagrammatic representation illustrating a manually activated postage meter, wherein the substrate is manually displaced relative to the print

head.

Figure 5a is an isometric representation of an exemplary apparatus for synchronizing the print speed and the manual displacement of the substrate.

Figure 5b is a side view of the same apparatus.

Figure 5c is a side view of the same apparatus showing a substrate being fed into the print zone.

Figure 5d is a side view showing the substrate being moved forward relative to the print head.

Figures 6a – 6g are timing diagrams illustrating the time relationship between the print head, the movement restraining mechanism, and the displacement of the substrate.

Figure 7 is a flow chart illustrating the method of synchronizing the print speed and the movement of the substrate, according to the present invention.

Detailed Description

The general principle of synchronizing the print speed and the movement of the substrate, according to the present invention, is shown in Figure 1. As shown, synchronization system **1** includes mainly four components: print head **2**, print-head control **4**, movement restraining means **6** and sensor **8**. System **1** can be used on a variety of value metering systems for synchronization. In particular, Figure 1 shows a postage meter for printing text or images on a mailpiece, which is herein referred to as a substrate. However, the value metering system can be a ticket printer to produce tickets for a concert, for a sporting event, or other gathering. The value metering system can also be used to print coupons or other value-redeemable items. Basically, movement restraining means **6** is used to restrict the movement of substrate **100**, such as an envelope or a tape, to be printed by print head **2** at print zone **12** in postage

meter. The movement of substrate **100** is relative to print head **2** and is denoted by arrow **110**. Thus, print head **2** can be located at a fixed location in the postage meter, and substrate **100** is advanced along direction **110**, as in a desk-top postage meter. It is also possible to move print head **2** against a stationary substrate **100** in a direction opposite to the arrow **110** (see Figure 3), as in a hand-held postage meter. It is understood that print head **2**, under the control of print head control **4**, is capable of printing a plurality of lines, one or more lines at a time. The printed lines are substantially perpendicular to moving direction **100**, as shown in Figure 2. The movement of substrate **100** is restricted during the printing of line **82** in indicium **80** or in other image or text by print head **2**. After a line is printed, print head control **4** sends signal **102** to release movement restraining means **6**, allowing substrate **100** to advance to the next print line position. After substrate **100** is moved to the next print line position, sensor **8** sends a signal **104** to movement restraining means **6** and print head control **4**. Responsive to signal **104**, movement restraining means **4** again restricts movement of substrate **100**, and print head control **4** signals print head **2** to print a new line, until last line **84** is printed. It should be understood that print head **2** can also be used to print return address **90**, mailing address **92** and message **94**, as shown in Figure 2.

Figure 3 is a diagrammatic representation illustrating hand-held postage meter **20**. As shown, hand-held postage meter **20** has housing **22** to include the components for printing indicium **80** or other text or image on substrate **100**, and the components for assisting or restricting the movement of postage meter **20** against substrate **100**. As shown, housing **22** includes user interface section **24** for allowing a user to specify the data to be printed and to start the printing process. User interface section **24** is operatively connected to print head control **4** for conveying data thereto. Movement restraining means **6** is operatively engaged with latch **26,** which is capable of stopping gear **28** from turning. A

plurality of rollers **34, 36** is used to assist the movement of postage meter **20** long direction **111**. Roller **34** is mechanically coupled to gear **30** via pulley system **32** and gear **30** is mechanically engaged with gear **28**. It is understood that when a user presses down postage meter **20** against substrate **100** while the user moves postage meter **20** along direction **111**, roller **34** rotates. Accordingly, gears **28**, **30** also rotate if latch **26** is not restricting the rotation of gear **28**. Sensor **8**, which can be an optical interrupter, a mechanical switch, or the like, is used to sense the relative displacement of postage meter **20** to substrate **100**. For example, sensor **8** can be arranged to sense the movement of the teeth of gear **30** such that when the rotation of roller **34** is equal to the width of one printed line by print head **2**, sensor **8** sends signal **104** to movement restraining means **6**. Movement restraining means **6** can include, for example, a push-pull solenoid, which pushes down latch **26** to restrict the movement of gear **28** upon receiving signal **104**. The engagement of latch to gear **28** is released after a new line is printed by print head **2**, as indicated in signal **102** sent by print head control **4**.

Figure 4 is a diagrammatic representation of manually activated postage meter **40,** wherein substrate **100** is manually displaced relative to print head **2** along direction **110**. As shown, postage meter **40** includes frame **41** to support upper body **42** and lower body **44**. Similar to housing **22** of hand-held postage meter **20**, as shown in Figure 4, upper body **42** includes user interface section **24**, print head **2**, print head control **4**, movement restraining means **6** and sensor **8**. The function of the components in upper body **42** is also similar to the function of the components in housing **22**, except that movement restraining means **6** in upper body **42** is used to restrict the movement of lower body **44** relative to upper body **42**. Preferably, upper body **42** is fixedly mounted to frame **41** and lower body **44** is movably mounted to frame **41**. Lower body **44** has registration wall **46,** which defines the point where print head **2** starts printing on

substrate **100**. Lower body **44** further comprises supporting surface **48** to support substrate **100** as substrate **100** is moved into lower body **44**. Preferably, substrate **100** is secured or trapped in lower body **44** after it reaches registration wall **46**. Subsequently, a user can move lower body **44** along with substrate **100** along direction **110**. Sensor **8**, in cooperation with movement restraining means **6**, restricts the movement of lower body **44** such that lower body **44** is allowed to move by a distance substantially equal to the width of one print line **82** (Figure 2) after each line is printed. The restriction is removed after last line **84** (Figure 2) is printed.

An exemplary design of the manually activated postage meter is shown in Figures 5a to 5d. As shown in Figures 5a and 5b, postage meter **130** has frame **134** for fixedly mounting upper body **140**, and movably mounting lower body **160** so as to allow lower body **160** to move relative to upper body **140** along direction **110**. Upper body **140** includes control box **142** for housing a plurality of components, which are not shown, including print head **2**, print head control **4**, movement restraining means **6**, and sensor **8**. Movement restraining means **6** is operatively engaged with latching device **144**, which is capable of stopping gear **146** from moving when latching device **148** is lodged between two of the teeth **148**. Upper body **140** has plate **150**, which is connected to a locking mechanism **154**, for fixedly mounting to frame **134**. Plate **150** also has restricting end piece **152**. The lower body **160** has inner wall **162** movably mounted to frame **134** for linear motion along direction **110**. Lower body **160** further includes lower frame **170**, which is fixedly mounted to inner wall **162**, and upper plate **164** extended from inner wall **162**. Lower frame **170** includes a number of shafts **172** for rotatably mounting plurality of roller supports **174**. Number of rollers **176** are rotatably mounted on roller supports **174**. Rollers **176** allow substrate **100** to be fed into lower body **160** between upper plate **164** and rollers **176**, as shown in Figure 5c. Upper plate **164** also has end structure **168** fixedly mounted thereon.

End block **165** has vertical wall **166** to serve as a registration wall, which stops substrate **100** when substrate **110** is fed into lower body **160** for printing. As shown in Figure 5a, upper plate **164** has opening **180**, allowing print head **2** (not shown) inside control box **142** to print indicium **80** or other image or text on substrate **100**. Once substrate **100** is properly fed into lower body **160**, the user can move lower body **160** along with substrate **100** along direction **110** for printing. Preferably, roller supports **174** are spring-loaded to provide an upward urging force against substrate **100** for securing substrate **100** between upper plate **164** and rollers **174.** The user can push lower body **160** using end structure **168** for moving lower body **160**. After the printing is completed, lower body **160** is moved over a certain distance along direction **110**, as shown in Figure 5d. Preferably, end block **165** is movably mounted on end structure **168**. When the printing is completed, the end block can be moved upward so that substrate **100** can be retrieved from the front end of lower body **160**. However, before the printing is completed, restricting end piece **152** prevents end block **165** from being completely displaced upward, as shown in Figures 5a- 5c.

Figures 6a – 6f are timing diagrams illustrating the time relationship between the print head, the print-head control, the movement restraining means and the sensor in a postage meter, with reference to time axis **T**, as shown in Figure 6g. As shown in Figure 6a, timing sequence **302** represents the print signal of the postage meter. The printing signal enables the print head at $t=t_0$ after a substrate is properly fed into the postage meter (see Figure 5c, for example). From t_0 to t_2, the print head prints a line on the substrate, as represented by the first pulse on time sequence **304**, as shown in Figure 3b. At the end of the line, the print head control conveys a signal to the movement restraining means, as indicated by the first pulse in time sequence **306** between t_1 and t_2, as shown in Figure 3c. When print head **2** is printing, the movement restraining means is activated, as indicated by the first pulse on time sequence

310 starting at $t=t_0$, as shown in Figure 6e. The movement restraining means is deactivated at t_2. Once the movement restraining means is deactivated, the substrate is allowed to move relative to the print head by a distance substantially equal to the width of a printed line. By then, the sensor activates the movement restraining means, as indicated by the first pulse on time sequence **312** between t_3 and t_4, as shown in Figure 6f. Subsequently, the print head prints a new line starting at t_4, as shown in time sequence **304.** The print cycle repeats until the last line is printed. The last line is printed by the print head from t_n to t_{n+2}, as shown on time sequence **304**. A last line signal, as shown in time sequence **308** of Figure 3d, is provided to override the end of line signal (time sequence **306**) between t_{n+1} and t_{n+2}. The movement restraining means is not activated again after the last line is printed. The system is reset after a new substrate is fed into the postage meter for printing. The last line signal puts an end to the printing process, as indicated by the negative-going edge at t_{n+2} on time sequence **302**.

The method of synchronizing the print speed of a digital print head and the relative movement of a substrate is illustrated in flow chart **200** of Figure 7. As shown, the power switch of the postage meter is turned on at step **202**. The user is prompted to feed a substrate and to select or type in data for printing at step **204**. The print head is activated or enabled at step **206** and the movement restraining means is activated at step **208** to restrict the relative movement between the substrate and the print head. The print head starts printing a line at step **210**. When the printed line is completed, as shown at step **212**, the movement restraining means is de-activated at step **214**. If the printed line is not the last line, the sensor activates the movement restraining means at steps **218** after the substrate has moved into a new position for printing the next line. If the printed line is the last line, the user is prompted to feed a new substrate and to specify the data for printing the new substrate.

It should be noted that lower body **160** of postage meter **130,** as shown in

Figures 5a - 5d, is designed to be manually advanced. However, lower body **160** can also be moved along direction **110** by a motor, or the like. Thus, the method and apparatus for synchronization, according to the present invention, are also applicable in a postage meter where a movement device is used to move the substrate or the print head.

Figures 1 – 6g have been described in regard to a postage meter. However, the synchronization method and apparatus of the present invention can be generally used in a value metering system. The value metering system can be a hand-held system, a counter-top system or other system. The value metering system can be used to print indicia on mailpieces, and can also be used to produce tickets, coupons and the like.

Thus, although the invention has been described with respect to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and various other changes, omissions and deviations in the form and detail thereof may be made without departing from the spirit and scope of this invention.

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